PLANNING THE MALAYSIAN COASTLINE – INTEGRATED SHORELINE MANAGEMENT PLAN

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ABSTRACT: *Integrated Shoreline Management Plan (ISMP) is a planning framework and tool developed to achieve sustainable coastal development based on up to date knowledge of the coastal environment and best development practices. Realizing the increasing trends of coastal erosion and conflicts, the Government of Malaysia through the Department of Irrigation of Drainage (DID) has planned the ISMPs for every states in Malaysia, with the main objective of providing guidelines on implementing sustainable coastal development while providing adaptation strategies to minimize the associated risks. The plan focuses on the evaluation of physical, environmental, and socio-economic aspects on top of extensive stakeholder consultations to provide coastal planning alternatives that fulfil the respective state requirements. As part of this plan, Decision Support Systems are introduced to allow the dissemination of the collected data, plan strategies and recommendations to the different stakeholders in order to achieve a consistent development evaluated by different government agencies and private sectors. This paper will discuss on the application of the ISMP's in Malaysia focusing on the ISMP State of Perlis, Malaysia, with a discussion on its benefits and challenges as well as examples of coastal adaptation.*

Keywords: Integrated Shoreline Management Plan (ISMP), Malaysia, climate change, adaptation, planning.

1. INTRODUCTION

The Malaysia coastline is rich with coastal resources and has abundance of natural biodiversity. The coastal areas support a major portion about 70% of the total population. It is the centre of socio-economic activities such as urbanization, ports, oil and gas exploitation, transportation and communication, fisheries and aquaculture, tourism, recreation and many more. However, the rapid pace of development activities in the coastal area has resulted in a conflict in the need for immediate consumption and the need to ensure the long-term supply of these resources. This has led to increased erosion areas, siltation, loss of coastal resources and the destruction of the fragile marine habitat.

Realizing the increasing trends of coastal erosion and conflicts, which threatens coastal population and biodiversity, the Government of Malaysia, through the Department of Irrigation of Drainage (DID) has carried out Integrated Shoreline Management Plans (ISMP) as Malaysia's response and support of Agenda 21 of the Rio Declaration 1992. It is synonymous in principle and context with the Integrated Coastal Zone Management Plans (ICZM). The ISMP program carried out by the DID is tailored along the principles of ICZM to address major issues and problems related to the shoreline. It is an integrated approach that takes into account all sectoral activities that affect the coastal areas including economic, social, environmental and ecological issues.

Integrated Shoreline Management Plan (ISMP) is a planning framework and tool developed to achieve sustainable coastal development based on up to date knowledge of the coastal environment and best development practices. It looks at the coastal area on a regional scale to optimize the use of the coastal resource through efficient and transparent stakeholder engagement as a tool to understand development requirements, minimize negative changes and reduce stakeholders' conflicts. It also allows for addressing uncertainty, particularly associated to climate change and define coastal adaptation strategies that address, in an adaptive manner, future coastal risk.

The DID has planned the ISMPs for every state in Malaysia, with the main objective of providing guidelines on implementing sustainable coastal development while providing adaptation strategies to minimize the associated risks. The plan focuses on the evaluation of physical, environmental, and socio-economic aspects on top of extensive stakeholder consultations to provide coastal planning alternatives that fulfil the respective state requirements. As part of

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this plan, Decision Support Systems are introduced to allow the dissemination of the collected data, plan strategies and recommendations to the different stakeholders to achieve a consistent and sustainable development evaluated by different government agencies and private sectors.

2. OBJECTIVES

The ISMPs are carried out individually for each State in Malaysia. They are managed and coordinated by Federal and State resources, focusing on the 4 km coastal fringe that extends 1 km inland and 3 km offshore but considering the coastal, marine and environmental conditions beyond the project boundaries.

The primary objective of the ISMP in Malaysia is to produce a technical document for describing and evaluating the study area including hydraulics and sediment transport, environment, social and economic aspects to deliver a management plan to support a sustainable development of the State's coastline. As stated in the government project specifications, the main objectives of the ISMP are to:

- Assist the State and various State government agencies or departments in making better decisions with respect to the development of the coastal areas;
- Reduce erosion and flooding risk posed to the coastal areas;
- Assist on the planning of the coastal land use;
- Assist in the tourism development for coastal communities and properties;
- Assist in the conservation of the environment

To achieve the project objectives, several activities are carried out which include:

- Assess the existing shoreline status and compare to the previous assessments to evaluate changes and potential erosion issues. Assessing the coastal status and understanding the conditions of the area is key to support the next phases of the ISMP;
- Appraise coastal protection options provided on previous assessments;
- Delineate coastal cells and management units for the study area and propose objectives and strategy for each unit;
- Provide specific shoreline management guidelines for specific development activities proposed along the study area;
- Provide a comprehensive decision support system (DSS) to assist authorities and other stakeholders in accessing the ISMP.

3. METHODOLOGY AND STAKEHOLDER ENGAGEMENT

The ISMP is carried out based on four (4) essential tasks that provide the framework to provide the advice and support for the definition of the objectives and strategies of the State coastline. These are:-

1. Understanding the existing environment;
2. Definition of coastal cells and management units;
3. Definition of Management Unit Objectives and Strategies to analyse individual management units and define the specific characteristics and objectives to set management strategies to meet the State individual objectives;
4. Stakeholder engagement, this plays an important role in the definition of the management unit objectives and the establishment of the ISMP guidelines.

3.1 Understanding the Existing Environment

To be able to work with natural environmental processes is important to achieve solutions that fit the natural conditions and meet the project objectives. It also allows identifying win-win opportunities that could enhance the overall society.

To achieve this, the natural environment must be carefully evaluated and considered in the evaluation and planning; thereby enabling improvements in overall conditions while reducing environmental impacts and even creating elements to facilitate better social outcomes and reducing capital and long-term maintenance costs.

Understanding the condition of the environment is not a simple task and requires a comprehensive evaluation of the several components as described below:

3.1.1 Physical and chemical environment

The physical and chemical environment focuses on all non-living aspects in the environment, both natural and man-made. These aspects include processes such as erosion, flooding, water quality, etc. The physical and chemical environment is important as it is intrinsically linked to the biological environment and social aspects discussed in the following sections.

The physical and chemical environment are divided into several topics, accommodating individual investigations, while sometimes multi-parameter studies are feasible:

- Bathymetry and Topography. The description of the land and underwater contours is one of the key elements in the evaluation of the study area.

In the definition of a successful shoreline management plan, the bathymetry and topographic contours must be carefully assessed to provide accurate contouring of land and underwater features.

- "Meteo-marine" is a term used to describe physical phenomena such as winds, atmospheric pressure variations, waves, currents, and storm surge. Astronomical tide levels, currents, and stratification effects are also included under this heading. Meteo-marine conditions will affect the long-term conditions of the coastal area:
  - Winds, pressure fields, air temperature, rainfall, insulation and cloudiness.
  - Waves are largely induced by winds and can play a key role in the definition of the flow, morphological, and navigational conditions of coastal areas, affecting both the type and size of proposed structures, etc.
  - Tide levels play a role on the definition of levels that allow safe conditions along the shoreline and they have significant impact on the cost of protective structures both for typical and extreme conditions.
  - Current flows play an important role in the design, construction and management of the coastline. Currents are a driving mechanism for processes e.g. morphology, water quality, sediment characteristics, etc.
  - Water salinity and temperature stratification processes (e.g. interface level and strength) can be also important components to analyse during the management and development of the coastline.
  - Morphology and sediment transport. Understanding the morphological conditions of the area is important ISMP could include the evaluation of erosion processes and protections measures may require artificial nourishment or proposed development that may require reclamation, dredging, construction of shelter structures, etc.
- Climate Change. Impacts of climate changes have the potential to alter the physical environment, thus potentially shifting the entire settings of the site. Climate change-induced impacts must be addressed in the context of the State development. However, often only limited site-specific literature is available. The Intergovernmental Panel on Climate Change (IPCC) predictions, however other local sources can provide additional estimations.
- Land Use, Hydrology, Drainage and Groundwater. The hydrological environment, drainage conditions, and groundwater flow across influence coastal conditions therefore these have to be evaluated including seasonal and yearly variations.
- Geotechnical, Geology and Soil Characteristics. Geological and geotechnical, or 'ground' evaluation to establish the physical and mechanical properties of the material within the area where the project is proposed.
- Local Water Quality/Geochemistry and/or Sediment Quality. In many cases, ISMP projects include polluted areas or areas that may have contamination concerns.
- Navigation conditions. Consideration should be given to the navigation conditions, requirements, and potential conflicts with coastal developments.
- Other processes. While addressing most of the processes, it should be noted that nature is complex and our understanding is constantly evolving. Therefore, it is important to evaluate/consider other processes that may be relevant to each infrastructure project.

Some of the data collection examples and model results are listed in **Figure 3.1** to **Figure 3.4** below:-

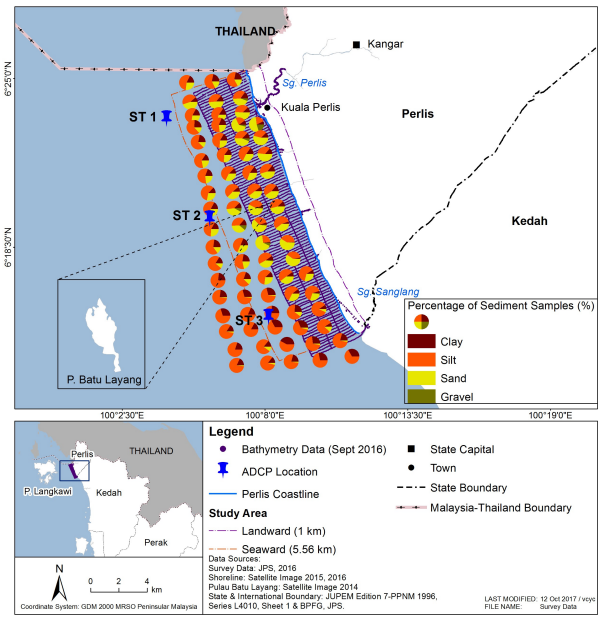

Figure 3.1: Example of bed sediment data collection and analyses results from ISMP State of Perlis, Malaysia.

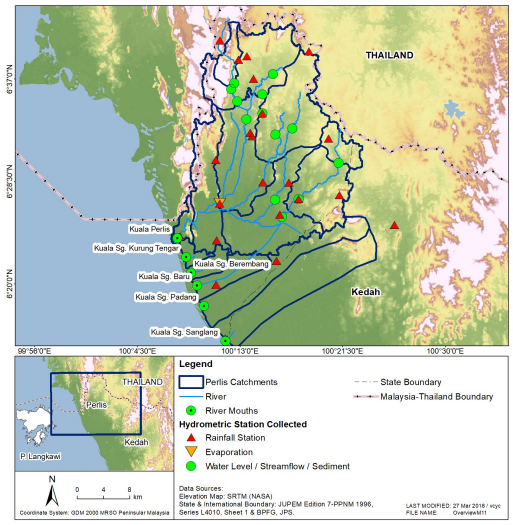

Figure 3.2 : Example of rainfall data collection from ISMP State of Perlis, Malaysia.

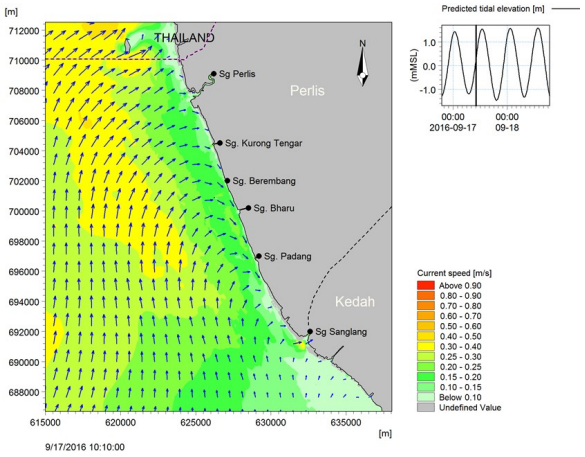

Figure 3.3 : Example of hydrodynamic model results from ISMP State of Perlis, Malaysia.

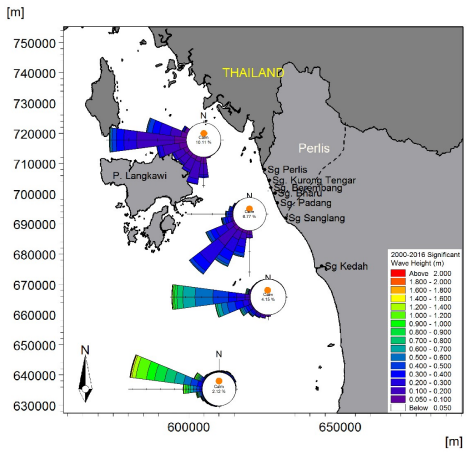

Figure 3.4 : Example of wave roses plots from ISMP State of Perlis, Malaysia.

3.1.2 Biological environment / Ecology

The ISMP focuses also on the understanding of the biological/ecological environment that focusses on all living organisms and processes. The biological environment is intrinsically linked to the physical and chemical environment and therefore it is important to determine the available resources and state, as this is important to accommodate sustainable future development. The focus is on:

- Coastal vegetation and Mangroves;
- Marine megafauna;
- Avifauna;
- Fish;
- Mudflats;
- Others.

3.1.3 Human Environment –Socio economics (and Culture)

Understanding the human environment involves the study of the study area in the context of existing and future development spaces and the associated economic and social functions and activities. The objectives of the ISMP must consider the social human environment to harmonize with existing and planned land use to sustain natural features in concert with accommodating necessary economic growth and sustainability. Typical aspects of economic growth to be considered include industry, housing, office, transportation, utilities (water supply, energy, wastewater), schools, recreation, both nature-based, such as parks and cultural landscapes, as well as large scale sports and public assembly facilities, public safety and security.

3.1.4 Environmental sensitive areas, reserves and conservation areas / heritage Areas

Most sites that receive protection under a conservation or heritage status do so because of their unique physical, chemical or biological environment. These protected areas are often a diversity of habitats that are protected for their unique conditions or habitants. Usually the most sensitive habitats are protected, while resilient or common habitats are often less of a priority.

Around the world, there are some common designations (for instance designation as a RAMSAR site) for the protection of wetlands and their habitants. Designations can be national, or local, privately managed.

Heritage sites are similar to conservation sites, yet these sites often protect human heritage, such as buildings, cities, sometimes through local or national protection, others through UNESCO world heritage protection.

3.1.5 Governance framework

A review of the environmental policies and legislation policies is carried out and specific attention is paid to key environmental impacts.

Legislative frameworks may be administered by federal and/or state-level government agencies and it is important to gain an understanding as to which agencies may play a part in the review of project designs. In addition, there may be policies and/or development plans that could be applied in development areas. These may include, but are not limited to, the following:

- Federal and State guidelines;
- Federal/State and Town planning guidelines;
- Integrated Shoreline Management Plan (ISMP)/Coastal Zone Management Plan (CZMP)
- Endangered fish and wildlife species;
- Cultural resources;
- Other Guidelines.

3.2 Definition of Coastal Cells and Management Units

For the purpose of shoreline management planning, it is necessary to divide the coastline into suitable units for which a Shoreline Management plan is prepared. Following that, the relevant unit for this purpose is a sediment cell, which is defined as a length of coastline that is relatively self-contained as far as movement of sediment and other suspended matter are concerned, and where interruptions of such movement will not have a significant effect on neighbouring cells. The boundary of a sediment cell typically coincides with a large estuary or prominent headlands. A shoreline management plan is a strategic plan for shore protection or shore development covering a sediment cell or sub-sediment cell.

For the strategic planning of specific development opportunities or land uses within the shoreline management area, it is required to further divide the sediment cell into management units. A Management Unit (MU) is defined as a stretch of coastline that possesses similar features in terms of physical, ecological and socio-economic characteristics as well as land use. Each MU has a number of features or characteristic elements that provide the basis to determine the management objectives upon which this unit will be managed. Once the management objectives have been determined, a number of strategies are put in place to be able to achieve these objectives in a sustainable and effective way.

An example of a MU delineation in the State of Perlis is given in **Figure 2.1**. For instance, a town district will be designated as a MU owing to its current urban land use type as well as the designated future urban land use as defined in the Local Plan of the area. In the case of the State of Perlis shoreline, the overall coast is connected with only one cell or sub-cell defined, and therefore no particular reference is made to this coastal cell in this ISMP but rather to management units. The characterization of the shoreline has been based on various elements of analysis, these include included hydrology and coastal processes, water quality, ecology, land use, socio-economy, governance; that are applied in an integrated manner to assist in the identification of the key features and definition of each individual management unit.

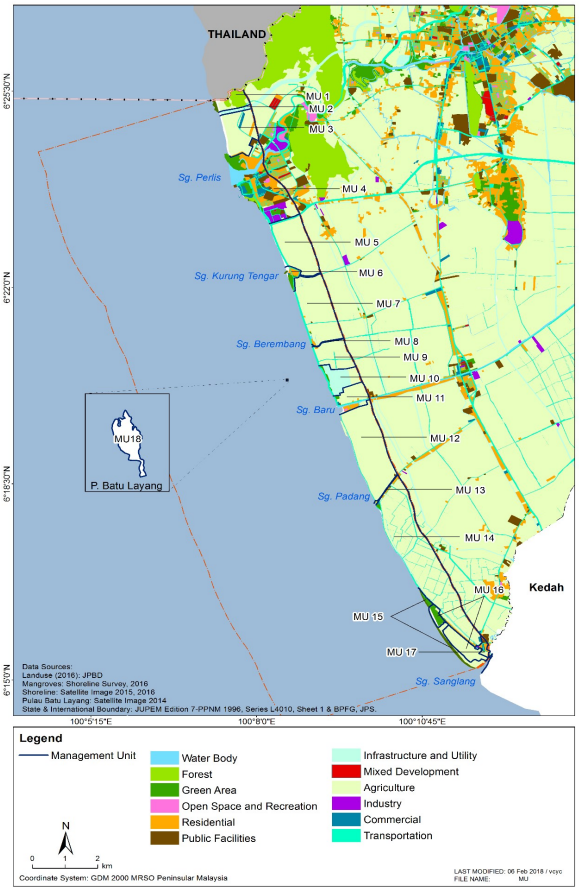

Figure 2.1 Example of management unit delineation for ISMP State of Perlis, Malaysia.

3.3 Definition of Management Unit Objectives and Strategies

Once each of the management units has been identified, an analysis of the features, benefits and issues along the coastline in each MU is carried to define the Management Objectives (MO) as well as the associated Management Strategies (MS) to meet those objectives.

Features and MOs are defined based on information gathered from the site visit, data collection, numerical

modelling and analyses and consultation carried out at early stages of the project.

The first element in this analysis is the dentification of key characteristic features of each MU; as well as the issues, threats, conflicts, proposed developments etc. These usually include:

- Coastal processes – morphology, erosion and flooding;
- Socio-economic values (ports, fishing jetties, hotels, housing, etc.);
- Environmental and ecological importance areas;
- Water quality;
- Historical or archaeological values;
- Recreational, landscape, aesthetical values;
- Particular value or relevance (protected areas or areas with particular usage).

Issues and opportunities are to be seen from a global perspective as they are not tied to some specific management units. Some of these issues may pose important challenges as well as opportunities which could benefit the state. Some of these challenges are specific while others can be more general. The former include how to deal with the pressure exerted by interested parties to build marine structures or reclaim land for development purposes, the need to preserve the natural environment, especially the mangroves and mudflats, against encroachment from new development whereas the latter are related to the risk of flooding, poor water quality, and sedimentation.

A strengths, weaknesses, opportunities and threats (SWOT) analysis is carried out for the project that allows the identification of advantages and resources for better managing the coastline while also identifying the areas of improvements or need for interventions outlined by the opportunities and threats.

Once the MU features, threats and opportunities are established, an overall objective is set for each individual MU. For example, “Agricultural and natural area – Preservation and conservation for ecological values and ecotourism potential” or “Sustainable urban and maritime development integrated with existing natural (and manmade) features to maximise tourism and recreational potential” followed by secondary objectives such as:

- Maintain river mouth stability, improve river flow conveyance capacity and allow safe navigation at river mouth.
- Protection against coastal flooding.
- Beautification and improvement of the present recreational features.
- Etc.

These MOs are proposed by the ISMP team and discussed/re-assessed with the different stakeholders through a number of workshops and presentations. The main idea of this process is to obtain the stakeholder views and feedback to produce objectives that are in line with the State plans and the stakeholders expectations. This process is key to obtain wider view of the State challenges and ambitions while address and resolve potential conflicts between different interests among the groups.

With the features and MO defined for each MU, the MS are set. The strategies are defined on a local scale but taking into consideration the regional processes that allows an optimization in the use of the coastal resources and provides solutions in a wider scale that is often required for coastal erosion process. An evaluation of uncertainty, particularly associated to climate change is part of the process, this is to define coastal adaptation strategies that address, in an adaptive manner, how to manage coastal risk in an acceptable and cost-effective manner.

3.4 Stakeholder Engagement

Make meaningful use of stakeholder engagement to identify issues, challenges, objectives, opportunities as well as conflicts is an important component of the ISMP. It is important that effective and timely stakeholder engagement is undertaken to ensure that the public and other interested parties can be engaged in a meaningful way in the process of decision-making.

Engagement of the public in the ISMP allows the ISMP project team to better understand the environment in which they are working and gives local communities and other stakeholders an opportunity to identify key issues of concern for their coastal areas.

Ideally an ISMP project should include a variety of different types of workshop/discussions/publications to different types of stakeholders. Key principles of the stakeholder engagement process include:

- Providing meaningful information in a format and language that is readily understandable and tailored to the needs of the target stakeholder group(s), for example in most cases the presentations/workshops are carried out in Bahasa Malaysia (local language) to get a better understanding and wider discussion of the issues, challenges and ambitions;
- Respecting local traditions, timeframes, and decision-making processes;
- Providing information in advance of consultation activities and decision-making;
- Disseminating information through means that allow ease of access by stakeholders;

- Providing two-way dialogues that offer each party the opportunity to exchange views and information, to listen, and to have their issues heard and addressed;
- Providing clear mechanisms for responding to people's concerns, suggestions, and grievances;
- Incorporating feedback into project design, and reporting back to stakeholders.

There are a number of benefits that can be obtained through an effective stakeholder engagement strategy. The benefits include:

- Enhanced effectiveness, public knowledge, understanding and awareness - Public participation can be a mechanism to break down and address complex decisions by different stakeholders who can provide new information, views, needs and interests;
- Meet growing demand for public participation - A growing public desire to be involved in decisions that will affect them has influenced the need for greater transparency in decision-making processes.

3.4.1 The ISMP Project Team

The ISMP is intrinsically a multi-disciplinary approach to shoreline management where different disciplines and expertise work together to achieve a sustainable approach to coastal development. It looks not only at the physical aspects but also environmental, human and economical aspect of the study area. As such, and to provide a wider overview, a study team with different backgrounds and expertise has to be set. This will enhance the proposed plans and solutions so that it is not merely ticking box exercise, but it goes beyond to identify long-term solutions and opportunities that are able to see beyond the usual issues. This is particularly important when looking at challenges like climate change.

4. DATA MANAGEMENT AND DECISION SUPPORT SYSTEM

As part of the ISMP study deliverables, a Decision Support System (DSS) – data management tool – is implemented to present the comprehensive set of data collected from both primary and secondary sources as well as the numerical modelling results and analyses, management units (MU) and their objectives and strategies. The DSS includes point and spatial data, information that usually includes:

- Reports – documentation of the management unit features, objectives and strategies.
- Hydrological and marine data, bathymetry and topographical contours, environmental sensitive areas, human activities, etc.;
- Measurements in point form – data in time-series describing precipitation, river discharge, water level, current velocities, water quality and potentially covering monitoring stations of the past;
- Spatial data – GIS data describing administrative borders, management units, existing and future land-use maps;
- Description of critical areas (with site photos) e.g. affected by flooding and/or erosion;
- Satellite or aerial (drone) images;

Usually ISMPs are carried every 15 years or more. The outcome of the studies are normally presented in hardcopy reports to be used by Authorities and other stakeholders. One of the limitations of this approach is that usually coastal conditions change, new developments are been proposed and also changes in the understanding of the study area change, for example the knowledge of climate change impacts and all these changes are not included in the report. One of the objectives of the DSS system is to have a more dynamic system that allows changes to be incorporated frequently so that an updated picture of the coastal conditions is readily available to the authorities. The second advantage of the DSS is that it can be accessed from different State offices and can support the State decision making. In this way it is possible to have a more consistent approach to land development and coastal preservation. The DSS system is normally configured at intranet (internal) level, however the possibility to publish on internet (external) level is also possible.

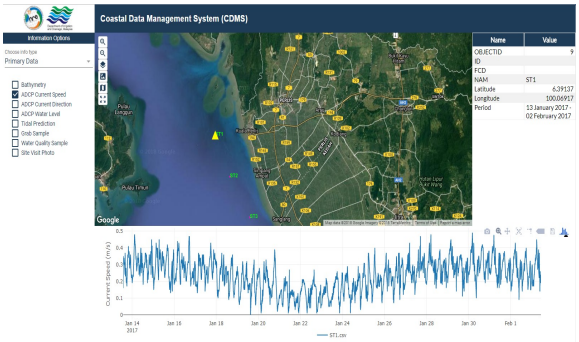

Figure 4.1 : Example of time series plot of current speed in the DSS for ISMP Perlis.

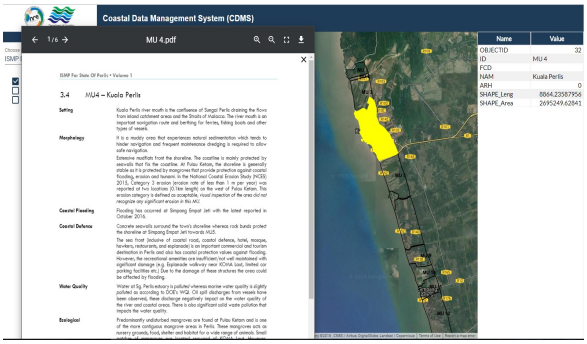

Figure 4.2 : Example of management unit description in the DSS for ISMP Perlis.

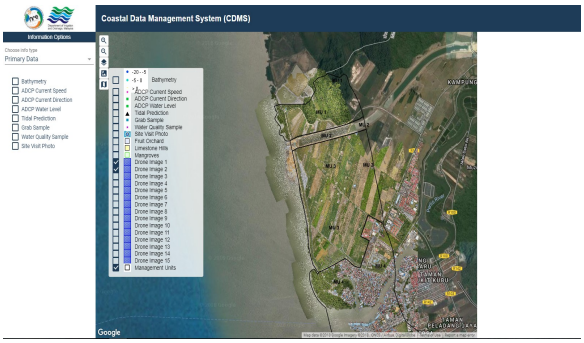

Figure 4.3 : Example of data collection presentation in the DSS for ISMP Perlis.

5. CONCLUSIONS

Malaysia, through the Department of Irrigation and Drainage (DID), is successfully implementing integrated shoreline managements along the nation coastline. These plans are designed to support the State development and implement adaptive measures to climate change. At the moment, nine (9) States ISMPs have been undertaken that represent 60.5 percent of the Malaysian coastline. The ambition of DID and the Malaysian government is to produce state wide ISMP plans that are available and easily accessible to different stakeholders in order to have a sustainable planning tool to support sustainable coastal development of the Malaysian coastline.

6. ACKNOWLEDGEMENTS

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REFERENCES

DID Manual (2009). Volume 3 – Coastal Management. Department of Irrigation & Drainage, Government of Malaysia.

Mangor, K. (2001). Shoreline Management Guidelines. DHI Publication.

Loganatham, N., Balasubramaniam, A.S. and Bergado, D.T. (1993). Deformation analysis of embankments. J. Geotech. Engrg. ASCE. 199(8):1185-1206.

Madhav, M.r. and Miura, N. (1994). Introduction. In: Miura, N., Madahav, M.R. and Koga, K.(Editors), Lowlands, Development and Management. A.A. Balkema, Netherlands and U.S.A.:31-37.

Moustakas, N. (1990). Relationship of morphological and physicochemical properties of Vertisols under Greek climate conditions. Ph.D. Thesis, Agricultural Univ. Athens, Greek.